Composites for Industrial Gas Turbines

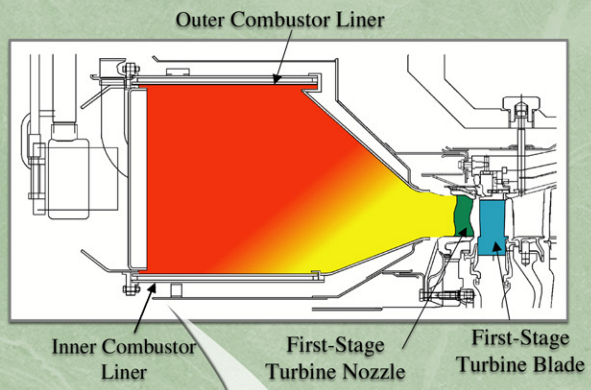
Solar Turbines has been investigating the use of ceramics in industrial gas turbines to improve fuel efficiency and reduce exhaust emissions of NOx and CO. Large air cooled metallic combustor liners have been successfully replaced by uncooled, fiber-reinforced ceramic-matrix composites (SiC/SiC fiber). Field tests in Bakersfield, CA and Lawrence, MA have verified that ceramic composites can survive for extended periods and significantly reduce exhaust emissions (<15 ppm NOx, <10 ppm CO)

Combustor Field Testing

A collaborative effort has developed and characterized continuous fiber-reinforced ceramic composite liners

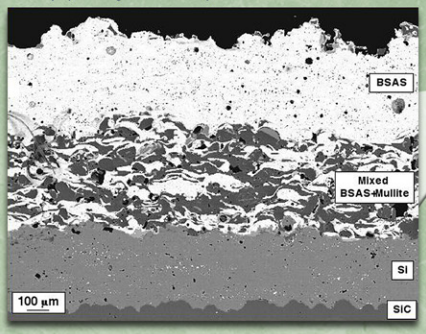
- Solar Turbines, Inc. - Engine Manufacturer
  - Texaco, Bakersfield, CA >> Engine test site
  - Malden Mills, Lawrence, MA >> Co-generation facility
- CFCC liner manufacturers
  - Honeywell Advanced Composites, Inc.
  - B.F. Goodrich, Inc.
- Pratt & Whitney / United Technologies Research Center
  - Environmental Barrier Coating (EBC) Development
- Oak Ridge National Laboratory
  - Laboratory-scale exposure of CFCCs (Keiser Rig)
  - Microstructural characterization of oxidation-induced surface damage
- Argonne National Laboratory
  - NDE inspection of liners

Industrial Gas Turbine

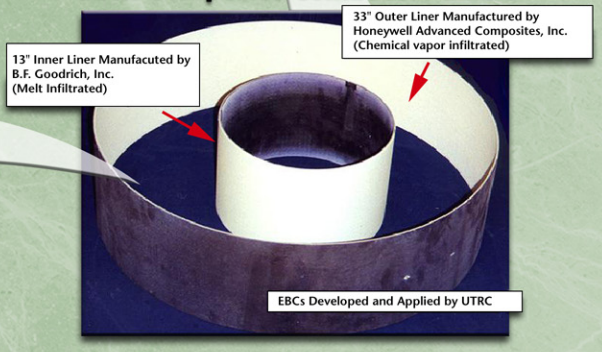


Environmental Barrier Coatings (EBCs) Currently Being Tested On Composite Liners

Plasma sprayed coatings consist of two layers on a Si bond coat and CVD SiC seal coat



EBCs are Applied to Working Surfaces of Both Composite Combustor Liners



Summary

- Nearly 20,000 hours of field testing proved that ceramic composite liners reduced exhaust emissions to ~15 ppm of NOx and 10 ppm CO
- A single EBC-coated composite liner survived nearly 14,000 hours at the Texaco field test in Bakersfield, CA
- A second industrial gas turbine is operating with ~6,000 hours and 52 starts at the Malden Mills facility in Lawrence, MA

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